Integrated Vehicle-Based Safety Systems (IVBSS) Objective Test Scenarios

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Presentation Outline

- IVBSS Program Background
- Motivation for Testing
- Overview of Tests
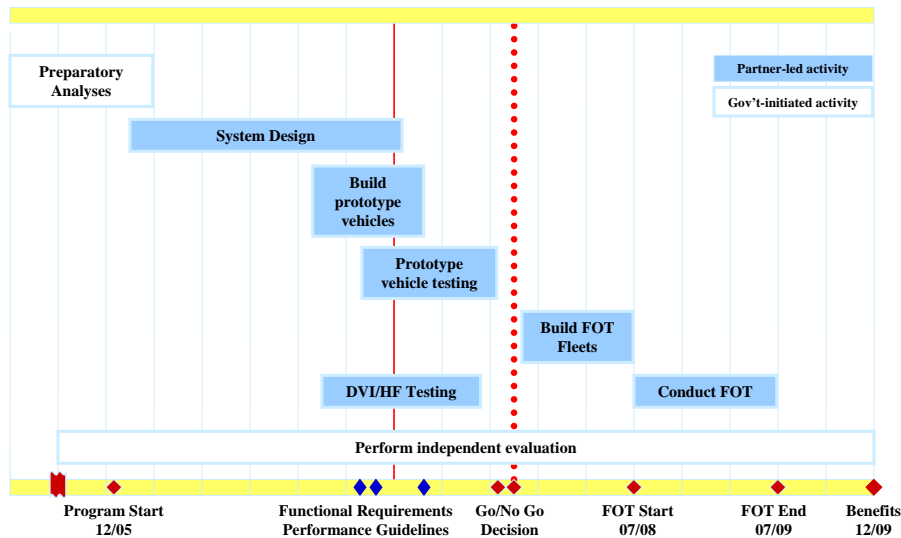- Summary
- For Further Information

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IVBSS Program Background

- Two phase program addressing rear-end, lane change and roadway departure crashes
- Goal is to obtain information on system effectiveness, user acceptance and estimate of safety benefits
- Will build and field test a fleet of 16 light vehicles and 10 heavy trucks equipped with prototype integrated safety systems

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IVBSS Program Schedule

Preparatory Analyses				Partner-led activity
				Gov't-initiated activity
System Design		
Build prototype vehicles	
Prototype vehicle testing	
Build FOT Fleets	
DVI/HF Testing	Conduct FOT
Perform independent evaluation				

| Program Start 12/05 | Functional Requirements Performance Guidelines 4/07-9/07 | Go/No Go Decision 12/07 | FOT Start 07/08 | FOT End 07/09 | Benefits 12/09 |

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Motivation for Prototype Testing

- Need to ensure system is ready for use by field test participants
- Will verify that prototype system design addresses target crashes
- Also measure on-road performance such as nuisance alert rate
- Results from all tests will support "go/no-go" decision to enter field test phase

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Objective Test Scenario Development

- Test scenarios used to exercise system were developed from analysis of crash databases
- Used most frequent and common pre-crash scenarios for each crash type
- Development process documented in NHTSA report and discussed in 2007 ESV Paper
  - *Crash Imminent Test Scenarios for Integrated Vehicle-Based Safety Systems, DOT HS 810 757, April 2007 (Najm and Smith)*
  - *Objective Test Scenarios for Integrated Vehicle-Based Safety Systems, ESV Paper 07-0183 (Najm, Ference, Szabo)*
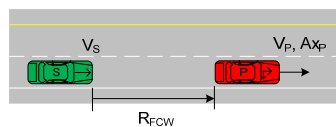
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Objective Test Scenario Development

- Prior work (CAMP, ACAS and RDCW FOTs) also used to guide development of procedures
- Categories of objective tests:
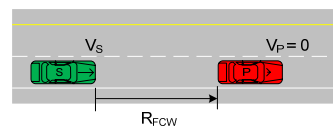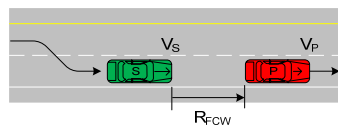 - Crash-imminent
  - No-warn

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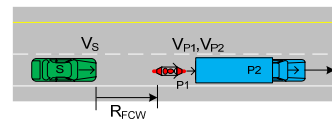# Sample Track Tests – Rear-end Crash

RE with slower moving POV in lane ahead

RE with stopped POV in lane ahead

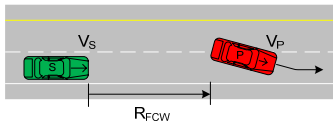RE with slower moving POV after lane change
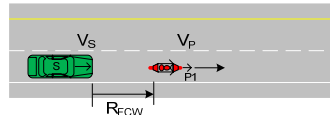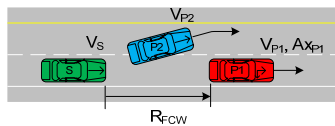

RE with motorcycle behind truck

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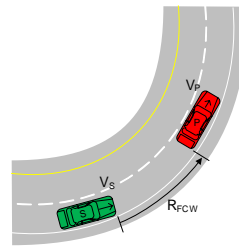# Sample Track Tests – Rear-end Crash

RE with slower moving POV after cut-in

RE with slower moving motorcycle ahead
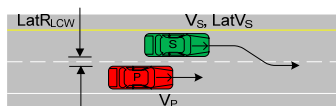

RE with POV revealed after POV cut-out

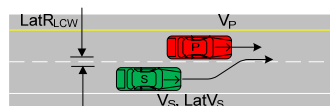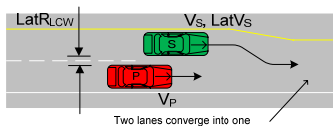RE with slower moving POV in curve

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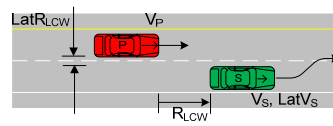# Sample Track Tests – Lane-change

LC into adjacent POV in blinds spot right

LC into adjacent POV in blind spot left

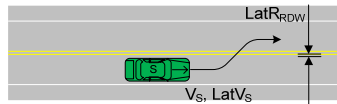LC into adjacent POV when merging
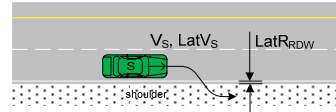

LC into approaching POV

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Sample Track Tests – Road departure

RD toward opposing lane of traffic
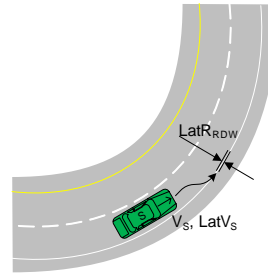
RD toward clear shoulder on straight road
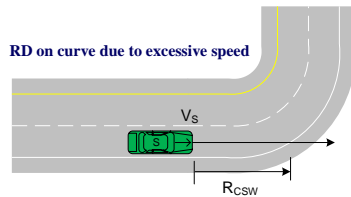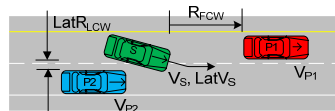
RD on curve due to excessive speed

RD toward clear shoulder on curve

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Sample Track Tests – Multiple-Threat

Avoid RE with slower POV1, then encounter LC with adjacent POV2
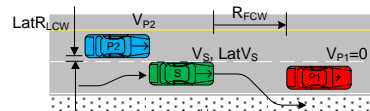
Avoid LC with POV2, then RE with stopped POV1 and encounter RD toward clear shoulder
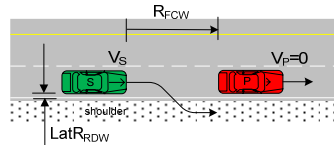
Avoid RE with stopped POV and encounter RD toward clear shoulder

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Sample "No Warn" Track Tests
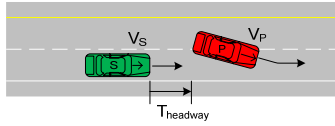
No FCW when faster POV cuts in front of SV
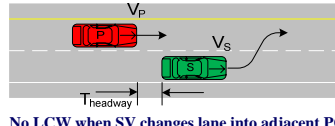
No LCW when SV changes lane into adjacent POV behind the SV rear bumper
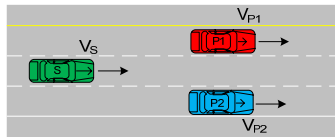
No FCW when SV approaches two POVs in adjacent lanes ahead
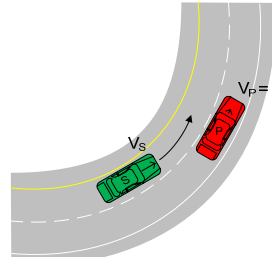
No FCW when SV passes stopped POV in adjacent lane on curve

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Test Procedure Content

- Purpose
- Test description
- Track setup
- Test parameters for validating test trials
- Pass/fail criteria
- Driving instructions

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Test Schematic

Initial conditions–Constant speed SV approaches from long range a slower-constant speed P1 at a closing rate greater than 8.9 m/s (20 mph)

R > 120 m
Rdot >= -8.9 m/s
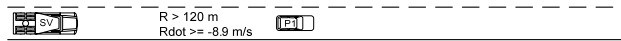
Warning conditions–A warning is issued at the appropriate range, FCWRange, per the system specification

R = FCWRange, m
Rdot >= -8.9 m/s

Conflict resolution–Following a warning or if range drops below 90% of the FCWRange (AbortRange), the conflict is resolved by both speed and lateral position changes.

Key:
Ax = Longitudinal acceleration
R = Range
Rdot = Range-rate

Subject vehicle

Principal other vehicle

Slowing   Constant speed   Accelerating

Lateral movement
right   left

Attempted lat. movement
right   left
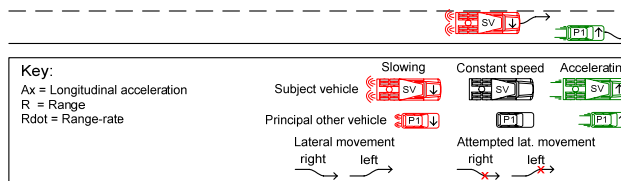
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Test Track Setup

Table RE-1.1 Pylon location relative to pylon 4

Pylon	Distance, m
1	378
2	137
3	74

Test-track setup*

Direction of travel

P1 'Go' command by SV driver

Pylon

P1 Start
P1 at Speed
Start of straight track

*Oval or circular test site is not required for this test.

Figure RE-1.1. Pylon placement to aide in the orchestration of the rear-end conflict with a constant speed POV

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Test Parameters

2.1.2 Performance measures and criteria for pass/fail determination

For a run of this test to be considered valid, the initial and transitional conditions for that run must be satisfied. These conditions are given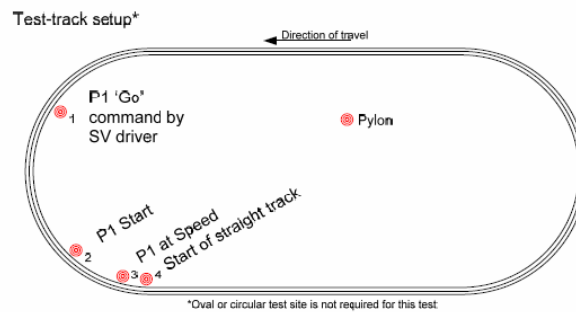 in Table RE-1.1. The table shows the performance measure variable, its target value, and acceptable tolerance. The notes below the table give the rules for evaluating if the initial conditions have been satisfied along with other criteria that if not followed invalidates the run.

Table RE-1.1. Run validity criteria for rear-end conflict with a constant speed POV.

Run validity criteria	Target Value	± Tolerance
V_{SV}, m/s	24.6 (55 mph)	1.0
V_{POV}, m/s	13.4 (30 mph)	1.0
$Rdot_{POV}$, m/s	-11.2	1.5
Initial R_{POV}, m	>150	N/A

- The minimum and maximum values of V_{SV}, V_{POV} and $Rdot_{POV}$ over a 3 second window ending at the time of the FCW cannot exceed the target values and their associated tolerances given above.
- The initial sensing range is greater than 150 m
- The sensitivity setting of the FCW system is set to 3, given an adjustment range of 1 to 5.
- The SV and POV drivers do not touch the brake pedal before the FCW is issued.

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Pass/Fail Criteria

- Both the SV and POV remain in the center of the designated lane until a FCW is issued.
- All standard test-conditions, test-settings and test-site criteria for this run are followed.

The criteria for passing a *Required* test involves successfully executing the test multiple times and thus ensuring that the system performance is repeatable and robust. The criteria for passing the test as a whole is given above in the section titled Criteria for Passing the Required Tests. Table RE-1.2 below gives the acceptable values and their tolerances for evaluating if the warning was issued per the design intent of the IVBSS subsystem. The note(s) below the table explain the procedure for evaluating the pass/fail performance measures.

Table RE-1.2. Pass/fail criteria for rear-end with a constant speed POV

Run pass/fail criteria	Target value	± Tolerance
R_{FCW}[4], m	42.5	2.0
$Rdot_{FCW}$, m/s	-11.2	1.5

- The value of R_{POV} and $Rdot_{POV}$ at the time of the warning is within the target value and associated tolerance for each measure shown in the table above.

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Summary

- Overview of Verification Test Procedures
- Verification test dry-runs in July-September
- Witnessed tests in September-October
- Go/No-Go decision in early November
- Finalized Test Procedures will be made publicly available in early 2008

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For Further Information

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IVBSS Webpage on FHWA ITS JPO:
http://www.its.dot.gov/ivbss.html

IVBSS Webpage on ITS America:
http://www.itsa.org/ivbss.html

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